Space Science Board, National Academy of Sciences

TEN YEAR PROGRAM IN SPACE SCIENCE

(Submitted by J. Lederberg 10/10/59)

Suggestions for planetary biology.

The detection and characterization of life beyond the earth is one of the principal aims of spaceflight research. To a greater extent than in the physical sciences, it is difficult to plan in detail beyond the initial steps, the information from which would be crucial for subsequent plans. The conclusions of planetary chemistry are especially important as a foundation for biological work. On the other hand pioneering studies must be conducted so as not to prejudice later efforts. Explicit recognition of aims in planetary biology is therefore needed, even in advance of detailed experimental planning.

The following outline is predicated on the following possibilities for vehicular and communications development:

The satellite telescope (in orbit around earth)

Planetary probes:

vicinal approaches	Mars, Venus, Jupiter, Moon
orbiters	Moon; Mars-Venus?
controlled landings	Moon, Mars, Venus
landing and return (unmanned)	Moon

Program (in rough sequence only)

1. Telescopic observations of Mars and Venus for organic substances in atmospheres or surface material.

2. Ditto, by vicinal approach (this competes with <1> if closer approaches, and consequent advantages in energy collection and angular orientation (i.e. size of collecting lens and its stabilization), compensate for costs of propulsion and guidance.

3. Orbiters: high resolution optical (including IR) surveys; vidicon photography with resolution of order of .1 to 1 meter might give evidence of vegetation. Applied to Moon, this would be important in choosing advantageous sites for chemical analysis, e.g. plutonic emissions.

4. Controlled landings. For the first time, these will permit explicit biological searches. In general, chemical analysis would precede any comprehensive biological survey.

Moon: Chemical and physical studies should take full precedence. Very large scale surveys would be necessary to detect the remotest possibility of dormant life at any point near the surface. Singularities in surface composition would be possible leads for biological followup in ultimate experimentation.

Mars and Venus: Larger organisms might be detected by their form or movement by vidicon surveys. More likely, a microscope input to the vidicon could detect microorganisms in the 'soil' and air-borne dust, either as such, or after nutrition with water and other substances. The same instrument could be used for simple cytochemical procedures to identify DNA and other important

components of terrestrial life. These biological surveys should be concurrent with chemical analysis, which should include tests for organic molecules. The spectrophotometer and mass spectrometer would be useful as terminal sensors for systems of biochemical analysis. Automatic culturing devices could increase the availability of particular kinds of microorganisms, e.g., phototrophs, for cytochemical analysis.

5. Return samples (Moon). For any scientific purposes, these should be hermetically sealed to avoid exposure to Earth's atmosphere upon re-entry. Fortunately, this precaution will also protect the samples for biological analysis. One can suggest some far-fetched possibilities -- e.g. search for spores or traces of DNA -- but probably it would be more reasonable to complete preliminary chemical studies before programming the biological work.

Even when it becomes technically possible, samples should not be returned from other planets until the consequences of possible biological contamination of the Earth have been exhaustively studied with the help of remote, telemetric instrumentation.

It is doubtful whether the question of return of manned flights to the planets will arise during the 10 year interval.

The interplanetary medium. Samples of interplanetary particles (collected from free space as well as on the lunar surfaces) will certainly be sought for chemical analysis. These should be collected in such a way as to conserve carbonaceous molecules that would be of biochemical interest. This qualification will make it necessary to develop new collecting devices avoiding the use of grease, paper, millipore filter membranes, and similar articles in current practice.